TRANSITIONING TO INDUSTRY TALKS

Collaborative Research on Lignocellulosic Biomass and Waste Conversion at the ABPDU

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Approach: Support both DOE and industry-funded projects relevant to biomass and waste conversion









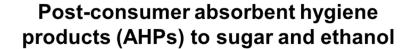
MSW blends to methyl ketones





Landfill-designated organic waste to sugars and acids









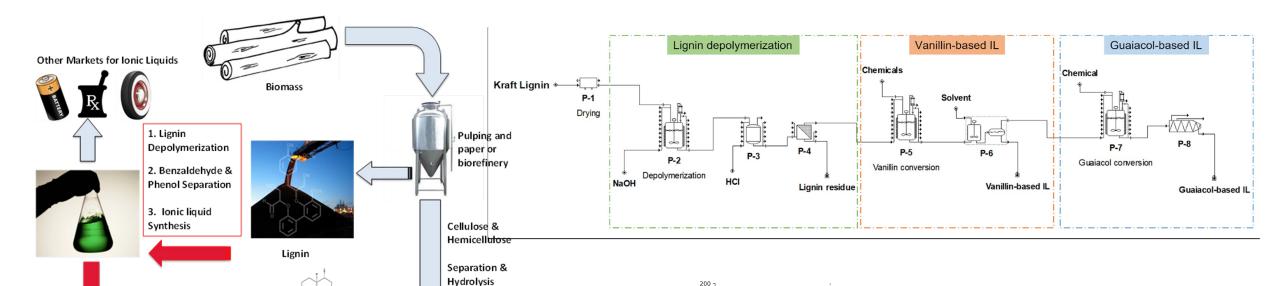
Almond hulls and shells torrefaction TEA



1. Sun et al, 2015, Bioresource Technology, 200. 2. Liang et al, 2017, RSC Advances, 36585. 3. Li et al, 2017, Biotech. Biofuel. 10, 13. 4. Liang et al. 2017, European Union Patent No. Patent Application# PCT/US2016/042863. 5. Liang et al. 2018, ACS Sustainable Chem. Eng. 6, 3589-3595. 6. Liang et al. 2019, U.S. Patent Application 62/578,248. 7. Yan et al. 2020, ACS Sustainable Chemistry & Engineering 2020. 8. Yan et al, 2019, ChemSusChem.

Progress and Outcomes: Lignin derived ionic liquids (LIL)

Fermentation



- Budget: \$500 K TCF funds+ \$500 K cost share
- TEA results indicate the potential of producing affordable ILs from kraft lignin and the MSP of LIL is \$14/kg with optimal case

Liu, S. et al. Green Chem., 2020, 22, 3917-3926.

Life-cycle assessment results show the potential to reduce GHG emissions by up to 85% relative to existing ILs ([Ch][Lys])

Bio-Manufacturing



Biopolymer Processing



Small scale

75 tonnes/day

150 -

of IL (\$/kg)



buyback buyback

Large scale

750 tonnes/day



Feedstock supply

Vanillin-based IL synthesis Guaiacol-based IL synthesis Credit: depolymerized lignin

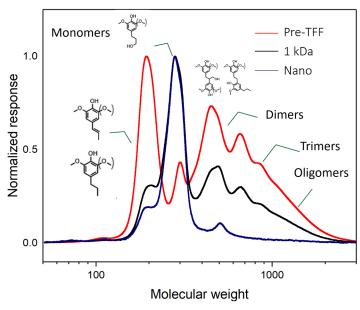


Dou et. al. in preparation

Progress and Outcomes: Lignin fractionation using Tangential Flow Filtration (TFF)

Permeate Permeate Permeate Permeate 2.7 µm 0.5 µm 25 kDa 2 kDa 1 kDa Nano

GPC analysis of permeate



TEA of the low MW lignin recovery cost



Retentate

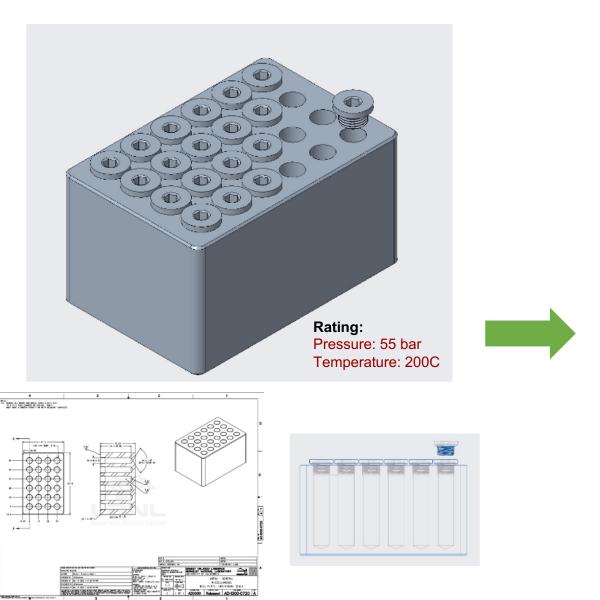
TFF system	Alfa Laval M20 (AL)			
Pretreatment catalysts	Sodium Hydroxide		Cholinium Lysinate	
Lignin (low MW + high MW) in black				_
liquor (g/kg)	44.74		123.4	
MW cut-off	5 kDa	< 400 Da	5 kDa	< 400 Da
Permeate recovery (%)	22.5%	1.9%	36.8%	2.1%
Annual running cost (\$/yr)	133,635	216,136	133,635	216,136
Annual low MW lignin production				
(tonne/yr)	794	67	3,580	204
Low MW lignin recovery cost				
(\$/tonne)	168	3,225	37.3	1,058

- AOP Budget: 150K per year
- TFF is capable of fractionating aqueous lignin streams
- A high initial concentration of lignin in the black liquor plays a critical role in the lignin product yield and recovery cost



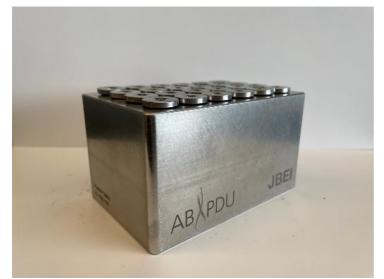


Progress and Outcomes: Capability Development for High throughput pressure reactor



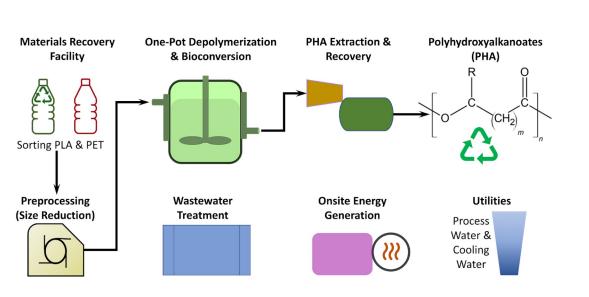


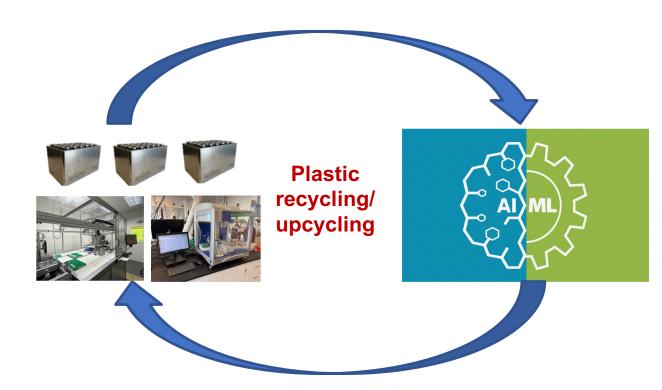






Progress and Outcomes: Depolymerization of polyester plastic mixtures using aqueous ionic liquid (IL)





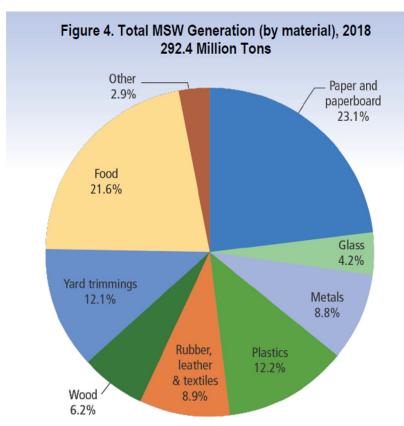
- CRADA Budget: 250K funds-in + 380K in-kind
- This study demonstrates the feasibility of applying ILs in depolymerization of PET and PLA mixtures using water as the bulk solvent
- The use of an aqueous solution of biocompatible IL allows the direct utilization of depolymerized stream in biological conversion
- Currently focusing on high-throughput screening of IL catalyst for PET depolymerization





Impact: Increase diversion rate of landfill-designated waste streams















Organics: $\sim 50\%$

Plastics: $\sim 20\%$



Impact: Advanced Recovery from wastewater

Volatile fatty acids (VFA) recovery after fermentation of wastewater Regenerant (0.5 % w/v NaOH) Resin recycling (up to 9 cycles) 30 min, 30°C Fermentation 65 - 72 %Broth VFA adsorption VFA solution Spent broth (Recovery: >90% of adsorbed VFA) **Kansas State University** ADVANCED MANUFACTURING OFFICE

Rare earth element (REE) recovery from mininginfluenced water (MIW)

